

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1. (previously presented): A method for the production of a hindered phenolic alkyl ester compound comprising:

- a) reacting methyl acrylate with an alkylphenol compound in the presence of a first catalyst to form a methyl ester intermediate compound,
- b) reacting an alcohol having at least 2 carbon atoms with the methyl ester intermediate compound in the presence of a second catalyst to form the hindered phenolic alkyl ester compound,
- c) neutralizing any catalyst residue with an aqueous phosphoric acid to form a precipitated phosphate salt, and
- d) separating the precipitated phosphate salt from the hindered phenolic alkyl ester compound.

Claim 2. (previously presented): The method according to claim 1, wherein the first and second catalysts have the same chemical composition.

Claim 3. (previously presented): The method according to claim 1, wherein the first and second catalysts have different chemical compositions.

Claim 4. (previously presented): The method according to claim 1, wherein the first catalyst is also used as the second catalyst during the reaction of the alcohol with the methyl ester intermediate compound.

Claim 5. (previously presented): The method according to claim 1, wherein the first and second catalysts comprise at least one compound selected from the group consisting of alkali and alkaline earth metal hydroxides and oxides, alkali metal

hydrides, alkali metal alkoxides, alkali metal amides, zinc salts, calcium salts, monoalkyltins, alkali metal hydrocarboxides, and mixtures thereof.

Claim 6. (previously presented): The method according to claim 1, wherein the first and second catalysts comprise at least one compound selected from the group consisting of potassium hydroxide, sodium hydroxide, lithium hydroxide, cesium hydroxide, calcium hydroxide, magnesium hydroxide, dibutyltin oxide, and mixtures thereof.

Claim 7. (previously presented): The method according to claim 1 wherein filtration is used to separate the precipitated phosphate salt from the hindered phenolic alkyl ester compound.

Claim 8. (currently amended): The method according to claim 1, wherein the hindered phenolic alkyl ester compound is formed in a substantially liquid form.

Claim 9. (previously presented): The method according to claim 1, wherein the alkylphenol compound is 2,6-di-tert-butylphenol.

Claim 10. (previously presented): The method according to claim 1, wherein the hindered phenolic alkyl ester compound formed is 3,5-di-tert-butyl-4-hydroxyhydrocinnamic acid, alkyl ester.

Claim 11. (currently amended): The method according to claim 1, wherein the molar ratio of methyl acrylate to alkylphenol is at least about 1:1.

Claim 12. (previously presented): The method according to claim 1, wherein a molar excess of methyl acrylate is employed so that the molar ratio of methyl acrylate to alkylphenol is greater than 1:1.

Claim 13. (previously presented): The method according to claim 1, wherein a molar excess of methyl acrylate is employed so that the molar ratio of methyl acrylate to alkylphenol is between about 1.05:1 to about 1.30:1.

Claim 14. (previously presented): The method according to claim 1, wherein a molar excess of alkylphenol is employed so that the molar ratio of alkylphenol to methyl acrylate is greater than 1:1.

Claim 15. (previously presented): The method according to claim 1, wherein a molar excess of alkylphenol is employed so that the molar ratio of alkylphenol to methyl acrylate is between about 1.05:1 to about 1.30:1.

Claim 16. (previously presented): The method according to claim 1, wherein the phosphoric acid comprises at least one compound selected from the group consisting of orthophosphoric acid (H_3PO_4), pyrophosphoric acid ($\text{H}_4\text{P}_2\text{O}_7$), metaphosphoric acid (HPO_3), phosphorous acid (H_3PO_3), and H_2PO_4 , and mixtures thereof.

Claim 17. (previously presented): The method according to claim 1, wherein the molar equivalent of aqueous phosphoric acid used is between about 10% and 200% of the total amount of catalysts used.

Claim 18. (previously presented): The method according to claim 1, wherein the molar equivalent of aqueous phosphoric acid used is between about 33% and 100% of the total amount of catalysts used.

Claim 19. (previously presented): The method according to claim 1, wherein the alcohol is a high molecular weight alcohol.

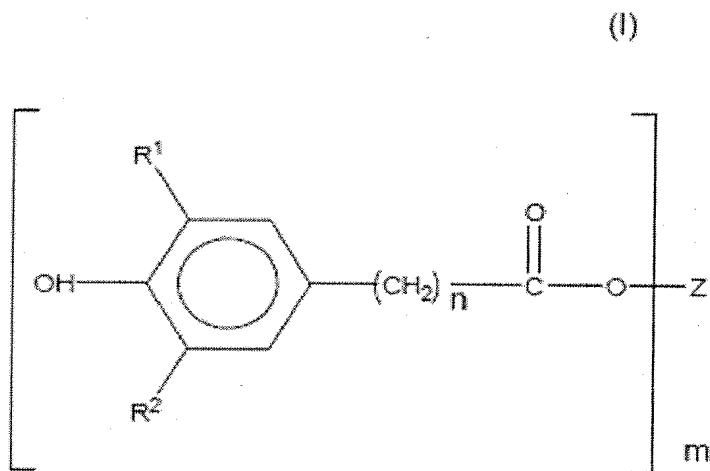
Claim 20. (previously presented): The method according to claim 1, wherein the methyl acrylate is reacted with the alkylphenol compound in the presence of a promoter.

Claim 21. (previously presented): The method according to claim 20, wherein the promoter comprises at least one compound selected from the group consisting of dialkyl sulfoxides, dialkyl formamides, dialkyl ethers, dimethyl acetamide, N,N-dialkyl

acidamide, methyl ethyl ketone, methyl butyl ketone, phase transfer agents, crown ethers, and mixtures thereof.

Claim 22. (previously presented): The method according to claim 20, wherein the promoter is tetrahydrofuran.

Claim 23. (previously presented): A method for the production of a hindered phenolic alkyl ester compound having the structure according to Formula I:



wherein:

R^1 and R^2 are independently selected from the group consisting of H, alkyl, cycloalkyl, aryl, alkylaryl, and arylalkyl;

n is 2;

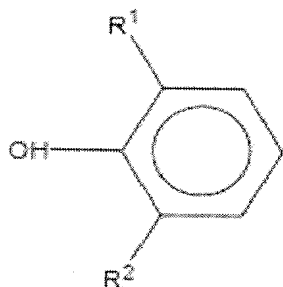
m is 1, 2, 3, or 4; and

Z is alkyl;

comprising the steps of:

a) reacting methyl acrylate with an alkylphenol compound in the presence of a first catalyst to form a methyl ester intermediate compound, wherein the alkylphenol compound has the structure according to Formula II:

(II)



and wherein R¹ and R² are defined as above;

- b) reacting an alcohol having at least 2 carbon atoms with the methyl ester intermediate compound in the presence of a second catalyst to form the hindered phenolic alkyl ester compound having the structure according to Formula I, and
- c) neutralizing the catalyst residue with an aqueous phosphoric acid to form a precipitated phosphate salt, and
- d) separating the precipitated phosphate salt from the hindered phenolic alkyl ester compound.

Claim 24. (previously presented): The method according to claim 23, wherein R¹ and R² are alkyl.

Claim 25. (previously presented): The method according to claim 23, wherein R¹ and R² are independently selected from t-butyl and C₁-C₆ alkyl.

Claim 26. (previously presented): The method according to claim 23, wherein R¹ and R² are t-butyl.

Claim 27. (previously presented): The method according to claim 23, wherein Z is C₂-C₂₀ alkyl.

Claim 28. (currently amended): A method for the production of a hindered phenolic alkyl ester compound comprising:

- a) reacting methyl acrylate with an alkylphenol compound in the presence of a first catalyst to form a methyl ester intermediate compound,

b) reacting an alcohol having at least 2 carbon atoms with the methyl ester intermediate compound in the presence of a second catalyst to form the hindered phenolic alkyl ester compound, wherein the second catalyst has the same chemical composition as the first catalyst,

c) neutralizing the first and second catalysts with an aqueous acid to form a precipitated salt, wherein the aqueous acid comprises at least one compound selected from the group consisting of sulfuric acid, phosphoric acid, and mixtures thereof, and

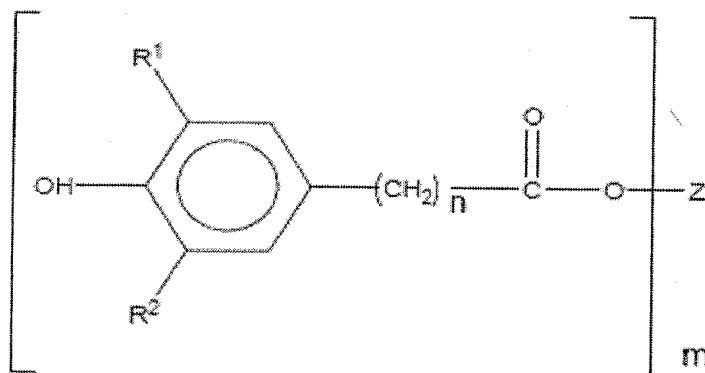
d) separating the precipitated salt from the hindered phenolic alkyl ester compound.

Claim 29. (previously presented): The method according to claim 28, wherein the first catalyst is also used as the second catalyst during the reaction of the alcohol with the methyl ester intermediate compound.

Claim 30. (currently amended): The method according to claim 28, wherein the aqueous acid comprises at least one compound selected from the group consisting of orthophosphoric acid (H_3PO_4), pyrophosphoric acid ($H_4P_2O_7$), metaphosphoric acid (HPO_3), phosphorous acid (H_3PO_3), and H_2PO_4 , and mixtures thereof ~~at least one compound selected from the group consisting of sulfuric acid, nitric acid, hydrobromic acid, hydroiodic acid, hydrochloric acid, formic acid, acetic acid, phosphoric acid, and mixtures thereof.~~

Claim 31. (currently amended): A method for the production of a hindered phenolic alkyl ester compound having the structure according to Formula I:

(I)



wherein:

R^1 and R^2 are independently selected from the group consisting of H, alkyl, cycloalkyl, aryl, alkylaryl, and arylalkyl;

n is 2;

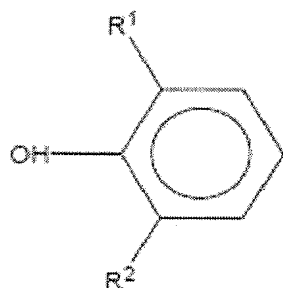
m is 1, 2, 3, or 4; and

Z is alkyl;

comprising the steps of:

a) reacting methyl acrylate with an alkylphenol compound in the presence of a first catalyst to form a methyl ester intermediate compound, wherein the alkylphenol compound has the structure according to Formula II:

(II)



and wherein R^1 and R^2 are defined as above;

b) reacting an alcohol having at least 2 carbon atoms with the methyl ester intermediate compound in the presence of a second catalyst to form the hindered phenolic alkyl ester compound having the structure according to Formula I, wherein the second catalyst has the same chemical composition as the first catalyst;

c) neutralizing the first and second catalysts with an aqueous acid to form a precipitated salt, wherein the aqueous acid comprises at least one compound selected from the group consisting of sulfuric acid, phosphoric acid, and mixtures thereof, and

d) separating the precipitated salt from the hindered phenolic alkyl ester compound.

Claim 32. (currently amended): A method for the production of a hindered phenolic alkyl ester compound comprising:

a) reacting methyl acrylate with an alkylphenol compound in the presence of a promoter and a first catalyst to form a methyl ester intermediate compound,

b) reacting an alcohol having at least 2 carbon atoms with the methyl ester intermediate compound in the presence of a second catalyst to form the hindered phenolic alkyl ester compound, wherein the hindered phenolic alkyl ester compound is formed in a ~~substantially~~ liquid form,

c) neutralizing any catalyst residue with an aqueous acid to form a precipitated salt, wherein the aqueous acid comprises at least one compound selected from the group consisting of sulfuric acid, phosphoric acid, and mixtures thereof, and

d) separating the precipitated salt from the hindered phenolic alkyl ester compound.

Claim 33. (previously presented): The method according to claim 32, wherein the promoter comprises at least one compound selected from the group consisting of dialkyl sulfoxides, dialkyl formamides, dialkyl ethers, dimethyl acetamide, N,N-dialkyl acidamide, methyl ethyl ketone, methyl butyl ketone, phase transfer agents, crown ethers, and mixtures thereof.

Claim 34. (previously presented): The method according to claim 32, wherein the promoter comprises at least one compound selected from the group consisting of dimethyl sulfoxide, dimethyl formamide, diethyl ether, diisopropyl ether, and mixtures thereof.

Claim 35. (previously presented): The method according to claim 32, wherein the promoter is tetrahydrofuran.

Claim 36. (currently amended): A method for the production of a hindered phenolic alkyl ester compound comprising:

- a) reacting methyl acrylate with an alkylphenol compound in the presence of tetrahydrofuran and a first catalyst to form a methyl ester intermediate compound,
- b) reacting an alcohol having at least 2 carbon atoms with the methyl ester intermediate compound in the presence of a second catalyst to form the hindered phenolic alkyl ester compound,
- c) neutralizing any catalyst residue with an aqueous acid to form a precipitated salt, wherein the aqueous acid comprises at least one compound selected from the group consisting of sulfuric acid, phosphoric acid, and mixtures thereof, and
- d) separating the precipitated salt from the hindered phenolic alkyl ester compound.

Claim 37. (previously presented): The method according to claim 36, wherein the alcohol is reacted with the methyl ester intermediate compound in the presence of tetrahydrofuran.

Claim 38. (currently amended): A method for the production of a hindered phenolic alkyl ester compound comprising:

- a) reacting an alkyl acrylate with an alkylphenol compound in the presence of a catalyst to form the hindered phenolic alkyl ester compound,
- b) neutralizing the catalyst with an aqueous acid to form a precipitated salt, wherein the aqueous acid comprises at least one compound selected from the group consisting of sulfuric acid, phosphoric acid, and mixtures thereof, and
- c) separating the precipitated salt from the hindered phenolic alkyl ester compound by filtration.

Claim 39. (previously presented): The method according to claim 38, wherein the alkyl acrylate is methyl acrylate.

Claim 40. (previously presented): The method according to claim 38, wherein the alkyl acrylate is a high molecular weight alkyl acrylate.

Claim 41. (previously presented): The method according to claim 40, wherein the high molecular weight alkyl acrylate is a C₂-C₁₀ alkyl acrylate.

Claim 42. (previously presented): The method according to claim 41, wherein the C₂-C₁₀ alkyl acrylate is a compound selected from the group consisting of n-butyl acrylate, sec-butyl acrylate, n-octyl acrylate, 2-ethylhexyl acrylate, isoheptyl acrylate, isooctyl acrylate, isononyl acrylate, isodecyl acrylate, and mixtures thereof.

Claim 43. (currently amended): The method according to claim 38, wherein the hindered phenolic alkyl ester compound is formed in a substantially liquid form.

Claim 44. (previously presented): The method according to claim 38, wherein the alkyl acrylate is reacted with the alkylphenol compound in the presence of an alcohol.

Claim 45. (previously presented): The method according to claim 44, wherein the alcohol is a high molecular weight alcohol.

Claim 46. (previously presented): The method according to claim 38, wherein the alkyl acrylate is reacted with the alkylphenol compound in the presence of a promoter.

Claim 47. (previously presented): The method according to claim 46, wherein the promoter comprises at least one compound selected from the group consisting of dialkyl sulfoxides, dialkyl formamides, dialkyl ethers, dimethyl acetamide, N,N-dialkyl acidamide, methyl ethyl ketone, methyl butyl ketone, phase transfer agents, crown ethers, and mixtures thereof.

Claim 48. (previously presented): The method according to claim 46, wherein the promoter is tetrahydrofuran.

Claim 49. (currently amended): The method according to claim 38, wherein the aqueous acid comprises ~~aqueous~~ the phosphoric acid.

Claim 50. (withdrawn): A composition produced according to the method of claim 1.

Claim 51. (withdrawn): A composition comprising:

- a) 3,5-di-tert-butyl-4-hydroxyhydrocinnamic acid, C₄-C₁₀ alkyl ester, wherein the 3,5-di-tert-butyl-4-hydroxyhydrocinnamic acid, C₄-C₁₀ alkyl ester has a gas chromatogram within the composition of about 80.0% to about 98.0% by area,
- b) pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] C₁-C₁₀ dialkyl ester, wherein the pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] C₁-C₁₀ dialkyl ester has a gas chromatogram within the composition of about 1.0% to about 20.0% by area, and
- c) 3,5-di-tert-butyl-4-hydroxyhydrocinnamic acid, methyl ester, wherein the 3,5-di-tert-butyl-4-hydroxyhydrocinnamic acid, methyl ester has a gas chromatogram within the composition of about 0.1% to about 5.0% by area.

Claim 52. (withdrawn): The composition of claim 51, wherein the 3,5-di-tert-butyl-4-hydroxyhydrocinnamic acid, methyl ester has a gas chromatogram within the composition of about 0.1% to about 1.0% by area.

Claim 53. (withdrawn): The composition of claim 51, further comprising 2,6-di-tert-butylphenol, wherein the 2,6-di-tert-butylphenol has a gas chromatogram within the composition of about 0.1% to about 5.0% by area.

Claim 54. (withdrawn): The composition of claim 53, wherein the 2,6-di-tert-butylphenol has a gas chromatogram within the composition of about 0.1% to about 1.0% by area.

Claim 55. (withdrawn): The composition of claim 51, wherein the 3,5-di-tert-butyl-4-hydroxyhydrocinnamic acid, C₄-C₁₀ alkyl ester has a gas chromatogram within the composition of about 90.0% to about 97.0% by area,

the pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] C₁-C₁₀ dialkyl ester has a gas chromatogram within the composition of about 1.5% to about 10.0% by area, and

the 3,5-di-tert-butyl-4-hydroxyhydrocinnamic acid, methyl ester has a gas chromatogram within the composition of about 0.1% to about 1.0% by area.

Claim 56. (withdrawn): The composition of claim 51, wherein:

the 3,5-di-tert-butyl-4-hydroxyhydrocinnamic acid, C₄-C₁₀ alkyl ester has a gas chromatogram within the composition of about 95.0% to about 98.0% by area,

the pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] C₁-C₁₀ dialkyl ester has a gas chromatogram within the composition of about 1.0% to about 2.5% by area, and

the 3,5-di-tert-butyl-4-hydroxyhydrocinnamic acid, methyl ester has a gas chromatogram within the composition of about 0.5% to about 1.0% by area.

Claim 57. (withdrawn): The composition of claim 51, wherein

the 3,5-di-tert-butyl-4-hydroxyhydrocinnamic acid, C₄-C₁₀ alkyl ester is 3,5-di-tert-butyl-4-hydroxyhydrocinnamic acid, isooctyl ester,

the pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] C₁-C₁₀ dialkyl ester comprises pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] diisooctyl ester and pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] methyl isooctyl ester.

Claim 58. (withdrawn): The composition of claim 51, wherein one of the alkyl ester groups of the pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] C₁-C₁₀ dialkyl ester is a C₄-C₁₀ alkyl ester.

Claim 59. (withdrawn): The composition of claim 51, wherein the pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] C₁-C₁₀ dialkyl ester comprises at least one compound selected from the group consisting of:

pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] dibutyl ester, pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] bis(2-ethylhexyl) ester, pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] diisooctyl

ester, and pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] diisoheptyl ester, and mixtures thereof, and

at least one compound selected from the group consisting of:

pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] methyl butyl ester, pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] methyl 2-ethylhexyl ester, pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] methyl isooctyl ester, pentanedioic acid, 2-[[3,5-di-tert-butyl-4-hydroxyphenyl]methyl] methyl isoheptyl ester, and mixtures thereof.

Claim 60. (withdrawn): A product comprising the composition of claim 51 and at least one material selected from the group consisting of a lubricant oil, a dispersant, a detergent, an antiwear additive, a supplemental antioxidant, zinc dialkyldithiophosphate, an alkylated diphenylamine, a viscosity index improver, a pour point depressant, a corrosion inhibitor, a rust inhibitor, a foam inhibitor, a supplemental friction modifier, and mixtures thereof.

Claim 61. (withdrawn): A product comprising the composition of claim 51 and at least one material selected from the group consisting of a lubricating oil, a detergent, a dispersant, zinc dialkyldithiophosphate, a corrosion inhibitor, a rust inhibitor, an alkylated diphenylamine, and mixtures thereof.

Claim 62. (withdrawn): A product comprising the composition of claim 51, a detergent, a dispersant, and zinc dialkyldithiophosphate.

Claim 63. (withdrawn): The product of claim 62 further comprising a lubricating oil.

Claim 64. (withdrawn): A product comprising the composition of claim 51, a corrosion inhibitor, a rust inhibitor, and an alkylated diphenylamine.

Claim 65. (withdrawn): The product of claim 64 further comprising a lubricating oil.

Claim 66. (withdrawn): The product of claim 61, wherein the detergent is present in an amount of about 1.0% to about 7.5% by weight of the product, the dispersant is

present in an amount of about 1.0% to about 7.5% by weight of the product, the zinc dialkyldithiophosphate is present in an amount of about 0.5% to about 1.5% by weight of the product, and the composition of claim 52 is present in an amount of about 0.1% to about 2.0% by weight of the product.

Claim 67. (withdrawn): The product of claim 64, wherein the corrosion inhibitor is present in an amount of about 0.01% to about 0.5% by weight of the product, the rust inhibitor is present in an amount of about 0.01% to about 0.5% by weight of the product, the alkylated diphenylamine is present in an amount of about 0.1% to about 1.0% by weight, and the composition of claim 52 is present in an amount of about 0.1% to about 1.0% by weight of the product.

Claim 68. (withdrawn): The product of claim 60, wherein the lubricant oil is selected from the group consisting of passenger car engine oils, heavy duty diesel engine oils, railroad oils, natural gas engine oils, turbine oils, rust oils, oxidation oils, slideway oils, hydraulic oils, industrial oils, automotive gear oils, automatic transmission fluids and manual transmission fluids, tractor fluids, universal tractor fluids, power steering fluids, gear lubricants, industrial oils, pump oils, and mixtures thereof.

Claim 69. (currently amended): A method for the production of a hindered phenolic alkyl ester compound consisting essentially of:

- a) reacting an alkyl acrylate with an alkylphenol compound in the presence of a catalyst to form the hindered phenolic alkyl ester compound,
- b) neutralizing the catalyst with an aqueous acid to form a precipitated salt, wherein the aqueous acid comprises at least one compound selected from the group consisting of sulfuric acid, phosphoric acid, and mixtures thereof, and
- c) separating the precipitated salt from the hindered phenolic alkyl ester compound by filtration.